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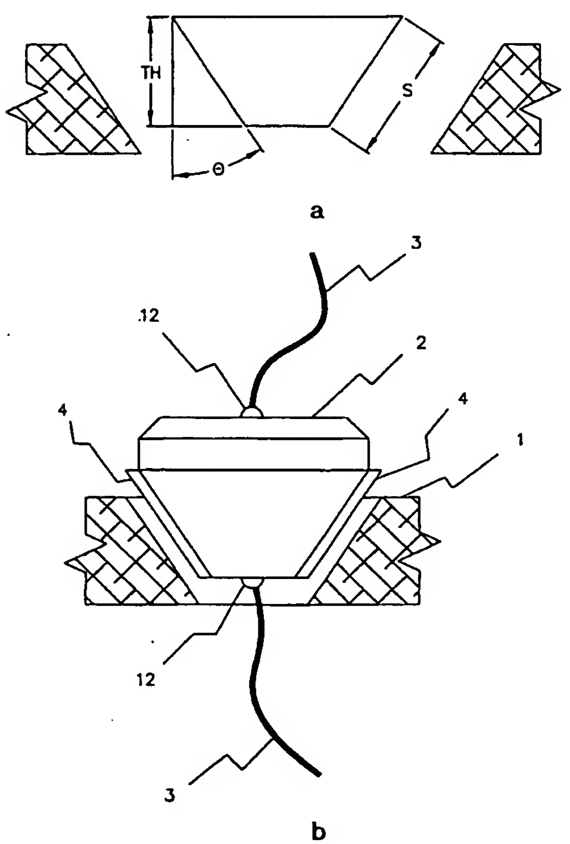
(54) Title: GOOD HERMETIC SEALS AND METHOD FOR MAKING THEM



(57) Abstract: This invention demonstrates good hermetic seals and method for making them. The quality of the hermetic seal is such that the penetration rate is equal to or less than 2×10^{-11} to 2×10^{-16} cc per second of helium atom at STP. Ni-titatium conical braze preforms or sputtered on or CVD or other deposition methods are used to prepare the surfaces or provide a braze preform for the surfaces to be bonded. Heating at about 1020 °C and pressure application of about 200 PSI applied together result in a good hermetic seal.

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GOOD HERMETIC SEALS AND METHOD FOR MAKING THEM

BACKGROUND OF THE INVENTION

Technical Field of the Invention

This invention relates to the fields of subminiature hermetic seals, sputtering, custom alloy formation, vapor deposition, ion implantation, pressure and temperature seal formation with a brazing substance.

The Prior Art

Prior art teaches that normally the vertical thickness of a cylindrical geometry compression hermetic seal must be at least 50 mils (about 1mm) to guarantee no leaking. (One mil is 0.001 inches or 0.0254 mm). Generally, this is necessary to keep an imperfection on the cylindrical surfaces where the feed-through wire and its containing jacket meet providing a leak pathway, particularly when quantities of the seals are being made.

A typical prior art example consists in heating up a green ceramic and letting it shrink around the wire. If the length of the seal is not thick enough, imperfections in the smoothness of the wire or the surrounding ceramic will allow unwanted penetration of the seal.

To achieve a better seal, an appropriate braze could be used, one that bonds with the metal and with the ceramic. Consider where a smaller plate on top covers the bottom plate. The bottom plate has a small hole through it, the hole to be sealed. Brazing material is placed on the top surface of the bottom plate around rim of the hole, and the top plate sits on that. Pressure can be applied by placing weights on the top plate, and the braze material can be heated up. The result would be a reasonable hermetic seal. However, the whole joined structure is the thickness of the bottom plate plus the thickness of the top plate. This is too thick for many important applications, and any thinning would require complex, expensive milling, and still would leave a bulge at the sealing structure. The invention herein discloses how to overcome these problems.

SUMMARY OF THE INVENTION

There is a long felt need for a high quality subminiature hermetic seal that is strong, thin and corrosion resistant. One quality of a hermetic seal is defined by the rate at which helium atom will penetrate the seal, at standard temperature and pressure (STP). A high quality seal might be one that has a penetration rate equal to or less than 2×10^{-11} to 2×10^{-16} cc per second of He atoms at STP. The current invention, hermetic seal, and method for making said seal, can also work above and below the leakage rates just cited.

This need has been long felt in the area of life-saving and medically therapeutic devices, which are implanted inside living tissue. Previously, implanted devices, which contained, for example, CMOS integrated circuits, were extremely vulnerable to small amounts of water. A small amount of water which leaked into a sealed container enclosing the CMOS chip would short circuit the chip and effectively destroy the function of the implanted device.

The long felt need for high quality hermetic seals also encompasses an hermetic seal which is thin and strong, so that devices utilizing them as a component, can be made as small as possible for implantation in living tissue. Also there are other uses, which requires a high quality hermetic seal that is thin and strong, such as underwater emplacement. Also, there is an ongoing need to have a high quality hermetic seal provide for an electrical connection from one side of a sealed barrier to the other. An aspect of this invention satisfies this need.

A coaxial compression seal, when made very thin in the direction of the leads will eventually leak if the finish on the lead or the compression insulator has a slight imperfection that traverses the sealed zone.

A braze could solve this problem because the braze can flow and fill-in the imperfection and be absorbed into the metal and into the ceramic. However, a brazed seal for the coaxial compression design doesn't provide the necessary pressure perpendicular to the direction of the leads and thus it cannot be made hermetic when using those non-corrosive brazes that require both heat and pressure to make the seal.

Most high temperature brazing, such as a ceramic with a strong oxidizable metal, which match the coefficient of expansion of ceramic, require a braze that matches said coefficient of expansion and require, for said braze, pressure of the order of over one hundred PSI. Aluminum oxide and zirconium oxide are

examples of such ceramics. Examples of strongly oxidizable metals include tantalum, titanium, niobium, and alloys of said metals.

An aspect of this invention shows both a method for making the hermetic seal, and the hermetic seal itself, that permits a high temperature braze to be applied with sufficient pressure to give a non-corrosive, high quality hermetic seal, thin and strong.

An aspect of this invention shows how to make a single layer thickness seal in which simple gravity can be used to apply the pressure during the heating of the braze. This invention shows a cone design followed by the thin film deposition of braze, or conical braze "washers", and surface machining of the cone and/or the mating surface to bring about a uniform "thin" thickness.

Prior art teaches a thickness of the hermetic seal of one mm or more, in the direction of the "cylindrical axis" compression type seals, above. Prior art teaches a brazing substance may be used. Advantageously, however, the current invention teaches, for ceramic types and for metal types suitable for implantation in living tissue, sufficient pressure as well as the necessary heat must be applied to achieve a good hermetic seal.

BRIEF DESCIPTION OF THE DRAWINGS

The above and other features and advantages of the invention will be more apparent from the following detailed description wherein:

Figure 1a shows the relationship of the slant height of the seal, the angle, and the thickness of the material in which the good hermetic seal is embedded.

Figure 1b shows a cutaway view of one of the hermetic seals for a conical structure (truncated cone).

Figure 2 shows hermetic seals for three objects and with the potential of different brazing materials on adjoining surfaces.

Figure 3 shows a more complex assembly with objects to be joined with high quality hermetic seals, thin and strong.

Figure 4 shows object, which is subjected to a downward force and supplies a pressure (force/area), at the joining surface.

Figure 5 shows the laminated nickel-titanium braze preform conical washer.

Figure 6 shows a sputtering chamber setup with two sputtering sources and an electromagnetic method of holding down and shielding small objects which are to be coated with a braze material.

DESCRIPTION OF PREFERRED EMBODIMENTS

The invention describes a method for forming non-corrosive, high quality hermetic seals, both thin and strong, and said seals, themselves, which are hermetic in the presence of imperfections in the mating surfaces. Another aspect of the invention disclosed here is a method for precisely depositing a very thin layer brazing material with a controlled composition on very small parts for these hermetic seals.

An aspect of the current invention shows high quality hermetic seals that may be thin and a method to make said seals. As mentioned in the prior art, a typical thickness of a viable hermetic seal has been around 50 to 100 mils (1.27 to 2.54 mm).

One aspect of this invention is that conical objects are sealed when they have a seal along a slant length from 5 to 15 mils, more preferably about 10 mils. Therefore, in the current invention, as shown in Fig 1a, when the slant length (s) of the conical object (91) equal to about 10 mils, there is a reliable hermetic seal. From this, one aspect of this invention, shows that, depending upon the angle of the conical object, the thickness of overall seal (th), (94) is less than 10 mils and if, for example, s = 10 mils for the next examples, then for $\theta = 30°$, th = 8.7 mils; for $\theta = 45°$, th = 7.1 mils; and for $\theta = 60°$, th = 5.0 mils.

Fig. 1b shows a cutaway view of one of the hermetic seals. A conical structure (truncated cone), (2), and rests in a complementary shaped mating structure (1). Two wires (3) are welded on either seal side to the metallic truncated cone. Welded attachments are shown at (12).

Brazing material is shown (4). This brazing material may be a conical "washer" of a material as a laminated layers of titanium (Ti) and nickel (Ni) or it may be applied by sputtering or vapor deposition, or, of a titanium and nickel

The method and seal shown uses pressure and temperature and a conical type of metal washer (4), that is, a braze preform, such as 1 part nickel to 1 part titanium, by weight, or, as shown in Fig. 5., a laminate with 1 part (by volume) of

nickel, (13), to 4 parts of (by volume) titanium, (14), to 1 part (by volume) of nickel (13). Under the heat from 1000 ^{0}C to 1100 ^{0}C, more preferably 1020^{0}C, and the pressure in excess of 100 lbs/sq. in., more preferably 200 lbs/sq. in., the conical titanium-nickel braze preform bonds the ceramic to the metal. The constraining factors are how to keep the hermetic seal thickness small while forming a very strong seal. A very strong seal is defined such that the objects (1) and/or (2) of Fig. 1b will have an equal or greater likelihood of breaking than the seals between (1) and (2) as can be seen in Fig. 2. A high quality hermetic seal is defined by allowing at most 2×10^{-11} cc of helium atom per second passing through the seal. Said hermetic seals of this invention have been measured to meet this definition of high quality and high strength, although said seals may operate above and below this penetration rate.

The solution is achieved by utilizing complementary beveled surfaces, which fit together, on the objects to be joined. As shown in Fig. 4, the forcing together of the truncated cone-like structure (2) and its complementary spatially shaped area of contact structure (1) gives rise to resultant forces.

Fig. 4 shows object (2), which is subjected to a downward force (9) and supplies a pressure (force/area) (10) at the joining surface. The angle θ is shown at (11). This angle determines the non-frictional, non-viscous component which (10) sees of (9).

Various weights at (9) are required to produce the required 250 lb./sq. in at (10). These weights are derived from the double of the non-frictional calculation, viz.: Weight required at (9) = [250 lb./sq. in] x [Area at (10)] x [sin θ].
For example, for a slant distance of 0.01036 inches, with the top area of the conical body having a Radius of 0.096 inches and a bottom area having a radius of 0.0038 inches, leads to a required weight sitting on top of 0.122 lbs, where θ is 34 °.

As shown in Fig. 2, and Fig .3, and Fig. 1, pressure is applied, as in Fig. 4, but also heating is applied. The heat acts to melt the brazing material, which can be placed prior to the assembly of the feed-through device, objects (1), (2). This brazing material is shown as (4), (5). These brazing materials may be the same on each surface to be brazed, or, some of them on the different surfaces may be different.

A particular temperature and pressure are useful with brazing substance, denoted here as BR1, as shown in Figs. (1), (2), and (3). Brazing substance BR1, a laminate or alloy of Ni (one part by weight) and Ti (one part by weight), which may be (4) and (6), works with a ceramic and a metal at temperature 990 to 1080 ^{0}C, preferably 1020 ^{0}C and a pressure of 170 to 290 PSI, preferably 200 PSI. At a temperature within the cited range, including 10200 C, and when a pressure within the cited range, including 200 PSI, is applied, brazing substances (4) and (5) tend to melt and interfuse (i.e. inter-diffuse) with the ceramic and/or metal interface(s). The effect of the "vertically applied" pressure, Fig 4, (9), on the truncated conical object (2) and its complementary mate (1) is such that the horizontal resultant forces cause an a mutual pressure on the joining surface, such that the brazing material, or (4) and (5), or (6) and (7) if they differ, tend to form a bond under that pressure and temperature so as to effectively and efficiently bond said object (1) and said (2) together in a high quality hermetic seal. A high-quality hermetic seal is formed at the contacting surfaces of objects (1) and (2), as in Fig. 1

Fig. 2 shows what is seen in Fig. 1, without the wires and solder-like attachments, but with the addition of a different type or different composition of brazing material (5) applied to the "anti-conical " surface.

An addition solid object is present (8), which is shown here as cylindrical surface of revolution. Two different brazing materials (6), (7), are shown at the joining surface of object (1) and object (8).

Fig. 3 shows a more complex assembly with objects (1), (2), and (8), to be joined with high quality hermetic seals, thin and strong. Three objects of conical shape are shown (2). The brazing material is shown as three separate conical "washers". Note that object (1) has three "anti-conical" holes to receive the conical objects (2). Object (1) is joined to (8) using a large conical brazing "washer". The assembly on (1) and (1) sits down into (8) in its own large "anti-conical" mating surface. As shown in Fig. 5., the conical brazing preform washer is a laminate with 1 part (by volume) of nickel, (13), to 4 parts of (by volume) titanium, (14), to 1 part (by volume) of nickel (13). Under the heat from 1000 ^{0}C to 1100 ^{0}C, more preferably 1020^{0}C, and the pressure in excess of 100 lbs/sq. in., more preferably 200 lb./sq. in., the conical titanium-nickel braze preforms bond the ceramic to the metal.

As discussed above, a typical application in the formation of a high quality hermetic seal, both thin and strong, often requires the placement of a bonding material on a conical or other shaped surface of small dimensions.

By sputtering or by chemical vapor deposition or by physical vapor deposition or by ion deposition, a layer of bonding or brazing material is placed or deposited on the required surface.

Typically, replacing conical washer type of brazing material such as a laminated nickel-titanium mixture, varying amounts of titanium and nickel can be sputtered onto the conical surfaces and/or the corresponding mating surfaces, of shape which will match the conical surface ("anti-conical"). The amounts by weight can correspond to 50%Ti and 50% Ni. The Ti {Fig 6., 66)} and Ni (67) can be deposited in alternating order {Fig. 6, (66), (67)} in small amounts, so as to form a more alloy-like composition before the application of heat and pressure (1020 ^{0}C and 200 PSI, respectively). For example, a layer of Ni 1000 Å thick, may be deposited, then a layer of Ti 4000 Å thick may be deposited, then a layer of Ni 1000 Å, and so forth. Thus, a braze coating of Ni (50%) and Ti (50%) may be achieved which also has the two metals more nearly mixed before heat and pressure are applied. The thickness of each layer may range down to a few Ångstroms. The relative percentage of the bonding material composition can be varied during the sputtering process so a composition of 54% Ni and 46% Ti (by weight), for example, can be achieved.

The use of the sputtering approach (i.e. selective deposition) allows for ease of manufacture because small conical brazing "washers" do not have to be individually placed on each small conical or anti-conical part. Rather, say, 1000 or so small parts may be placed, in a chamber (Fig. 6, 61), say, so as to receive sputtering (selective deposition). Those areas of the small parts (62) not to receive the brazing substance may be covered with a material (63) that is sufficiently responsive to a magnetic field from an electromagnet (64). Thus, when a local magnetic field is turned on (65), those magnetically active covering materials (63) will shield those areas of the small parts (62) which are not to receive the sputtered (66), (67), or otherwise deposited, brazing material. Simultaneously, those magnetically active covering materials (63) contribute toward locking those small parts (62) in place by being pulled downward toward

the local magnetic field. This pull supplements along the normal gravitation field in keeping said small objects in place.

In addition to the sputtering method and resultant sputtered brazing material, additional methods and resultant brazing surfaces include chemical and physical vapor deposition and ion implantation. Consequently, extremely small parts can be coated with an appropriate brazing material.

It is understood that the invention is to be limited only by the scope of the appended claims:

What is claimed is:

1. A method of forming a highly effective hermetic seal between a plurality of objects comprising the steps of:

a. coating joining surface with a bonding material on the joining surface of object (1) or of object (2), or on both, or between the joining surfaces of said objects (1) and (2), or, on said both surfaces and between said joining surfaces;

b. Bringing together said plurality of objects wherein the first of said objects has that part of itself;

c. contacting the second of said objects at an angle θ and wherein the corresponding part of said second object has that part of itself which contacts said first object at an angle ψ such that $\psi = 180° - \theta$, where said angles θ and ψ are given in degrees, and said angle θ is greater than 0.001 degrees and less than 89.999 degrees;

d. bringing the plurality of said objects together with pressure applied to said objects and said pressure is applied to objects (1) and (2) so as to force together the joining surfaces, said pressure being applied to the top and bottom of the loose assembly (1) and (2);

e. heating said objects (1) and (2) and heating said bonding material while pressure is being applied.

2. The method as in claim 1 further comprising the step of utilizing a brazing material comprising a metal conical washer consisting mainly of Nickel and Titanium, each in a ratio of (100% - x%) of Ni by weight, to, x% of Ti by weight, where $1\% < x < 99\%$.

3. The method as in claim 1 further comprising the step of utilizing a brazing material comprising a metal conical washer consisting mainly of Nickel and Titanium, each in a ratio of one part Ni to one part Ti, by weight.

4. The method as in claim 1 further comprising the step of using a sputtered brazing material that is used instead of, or together with, the conical washer.

5. The method as in claim 4 further comprising the step of sputtering-on a brazing material which has the ability to facilitate the bonding of ceramic and metal under elevated temperatures and pressures so as to form a good hermetic seal.

6. The method as in claim 4 further comprising the step of alternating the sputtering-on, in small amounts, of two materials which comprise the brazing material, for example Ti and Ni.

7. The method as in claim 4 further comprising the steps of

a. covering the areas of the parts, which are not to receive the brazing substance with magnetically active material;

b. turning on a local magnetic field that acts to hold down the parts being brazed.

8. The method as in claim 4 further comprising the step of utilizing a brazing material comprising a metal mixture consisting mainly of Nickel and Titanium, each in a ratio of (100% - x%) of Ni by weight, to, x% of Ti by weight, where 1% < x < 99%.

9. The method as in claim 4 further comprising the step of using a mixture of 50% by weight Ti and of 50% by weight Ni as the mixture/alloy to be sputtered.

10. The method as in claim 1 further comprising the step of vapor depositing said brazing material onto the joining surface or the plurality of joining surfaces that is used instead of, or together with, the conical washer.

11. The method as in claim 10 further comprising the steps of:

a. applying elevated temperature and;

b. applying elevated pressure

so as to facilitate the bonding of ceramic and metal under elevated temperatures and pressures so as to form a good hermetic seal.

12. The method as in claim 10 further comprising the step of alternating the vapor deposition, in small amounts, of two materials which comprise the brazing material, for example Ti and Ni.

13. The method as in claim 10 further comprising the step of utilizing a metal consisting mainly of Nickel and Titanium, each in a ratio of (100% - x%) of Ni by weight, to, x% of Ti by weight, where $1\% < x < 99\%$.

14. The method as in claim 10 further comprising the step of using a mixture of 50% by weight of Ti and of 50% by weight of Ni as the mixture/alloy for vapor deposition.

15. The method as in claim 1 further comprising the step of ion implanting brazing material onto the joining surface or the plurality of joining surfaces that is used instead of as well as together with the conical washer.

16. The method as in claim 15 further comprising the steps of:

a. applying elevated temperature and;

b. applying elevated pressure

so as to facilitate the bonding of ceramic and metal under elevated temperatures and pressures so as to form a good hermetic seal.

17. The method as in claim 15 further comprising the step of alternating the ion implantation, in small amounts, of two materials which comprise the brazing material, for example Ti and Ni.

18. The method as in claim 15 further comprising the step of utilizing a brazing material consisting mainly of Nickel and Titanium, each in a ratio of (100% - x%) of Ni by weight, to, x% of Ti by weight, where 1% < x < 99%.

19. The method as in claim 15 further comprising the step of using a mixture of 50% by weight Ti and of 50% by weight Ni as the mixture/alloy for ion implantation.

20. The method as in claim 4 further comprising the steps of:

a. covering the areas of the parts which are not to receive the brazing substance

with magnetically active material;

b. turning on a local magnetic field that acts to hold down the parts being brazed.

21. The method as in claim 1, or claim 5, or claim 11, or claim 16 further comprising the steps of milling one side, and the other side, if required, of a joined structure comprising said conical and said mating object, wherein a controlled thinness of the joined structure is achieved.

22. The brazed surface which results from the application of the brazing material as in claim 4 or as in claim 10 or as in claim 15.

23. A highly effective hermetic seal comprising two surfaces joined together by a brazing compound wherein heat and pressure were applied to the brazing material and the two mated surface, further comprising a metal surface, a ceramic surface and a brazing substance consisting mainly of Ni and Ti, in a ratio of (100% - x%): x% respectively, by weight, where x may range from 1% to 99%.

24. The highly effective hermetic seal of claim 22, wherein one of the surfaces joined is conical and the cone angle, from the vertex, or, for a truncated cone, that cone angle which would exist, if the truncated cone were extended, is

θ, where $0.001° < \theta < 89.999°$ and further comprising the other surface to which the conical surface joins, forms a mating surface which has a corresponding angle of $\psi = 180° - \theta$.

25. The highly effective hermetic seal of claim 23 wherein the brazing material is originally a conical washer before heat and pressure are applied.

26. The highly effective hermetic seal of claim 23 wherein the brazing material is originally sputtered on before heat and pressure are applied.

27. The highly effective hermetic seal of claim 23 wherein the brazing material is originally vapor deposited before heat and pressure are applied.

28. The highly effective hermetic seal of claim 23 wherein the brazing material is originally ion deposited.

29. The highly effective hermetic seal as in claim 24, or as in claim 25, or as in claim 26, wherein the brazing material comprised alternating thin layers of two materials which comprise the brazing material, for example Ti and Ni before the application of heat and temperature.

30. The highly effective hermetic seal as in claim 24, as in claim 25, or as in claim 26, wherein said brazing material consists mainly of Nickel and Titanium, each in a ratio of (100% - x%) of Ni by weight, to, x% of Ti by weight, where $1\% < x\% < 99\%$.

31. The highly effective hermetic seal as in claim 24, or as in claim 25, or as in claim 26, wherein said brazing material consists mainly of a mixture of 50% by weight Ti and of 50% by weight

32. The manufacturing jig comprising a holding surface for the small parts to be brazed, one or more brazing apparatus, magnetically active covering material,e.g. iron, steel,), local field producing electromagnet(s), with switching mechanism(s) to turn it (them) on and off.

AMENDED CLAIMS

[received by the International Bureau on 20 February 2001 (20.02.01); original claims 1-32 replaced by amended claims 1-32 (5 pages)]

1. A method of forming a highly effective hermetic seal between a plurality of objects comprising the steps:

a. coating a joining surface with a bonding material on the joining surface of object (1) or of object (2), or on both, or between the joining surfaces of said objects (1) and (2), or, on said both surfaces and between said joining surfaces;

b. bringing together said plurality of objects wherein the first of said objects has that part of itself;

c. contacting the second of said objects at an angle θ and wherein the corresponding part of said second object has that part of itself which contacts said first object at an angle ψ such that $\psi = 180° - \theta$, where said angles θ and ψ are given in degrees, and said angle θ is greater than 0.001 degrees and less than 89.999 degrees;

d. bringing the plurality of said objects together with pressure applied to said objects and said pressure is applied to objects (1) and (2) so as to force together the joining surfaces, said pressure being applied to the top and bottom of the loose assembly (1) and (2); and

e. heating said objects (1) and (2) and heating said bonding material while pressure is being applied.

2. The method as in claim 1 further comprising the step of utilizing a brazing material comprising a metal conical washer consisting mainly of Ni and Ti, each in a ratio of (100% - x%) of Ni by weight, to x% of Ti by weight, where $1\% < x < 99\%$.

3. The method as in claim 1 further comprising the step of utilizing a brazing material comprising a metal conical washer consisting mainly of Ni and Ti, each in a ratio of one part Ni to one part Ti, by weight.

4. The method as in claim 1 further comprising the step of using a sputtered brazing material that is used instead of, or together with, the conical washer.

5. The method as in claim 4 further comprising the step of sputtering-on a brazing material which has the ability to facilitate the bonding of ceramic and metal under elevated temperatures and pressures so as to form a good hermetic seal.

6. The method as in claim 4 further comprising the step of alternating the sputtering-on, in small amounts, of two materials which comprise the brazing material, for example Ti and Ni.

7. The method as in claim 4 further comprising the steps of:

a. covering the areas of the parts which are not to receive the brazing substance with magnetically active material; and

b. turning on a local magnetic field that acts to hold down the parts being brazed.

8. The method as in claim 4 further comprising the step of utilizing a brazing material comprising a metal mixture consisting mainly of Ni and Ti, each in a ratio of (100% - x%) of Ni by weight, to x% of Ti by weight, where $1\% < x < 99\%$.

9. The method as in claim 4 further comprising the step of using a mixture of 50% by weight Ti and of 50% by weight Ni as the mixture/alloy to be sputtered.

10. The method as in claim 1 further comprising the step of vapor depositing said brazing material onto the joining surface or the plurality of joining surfaces that is used instead of, or together with, the conical washer.

11. The method as in claim 10 further comprising the steps of:

a. applying an elevated temperature and

b. applying elevated pressure so as to facilitate the bonding of ceramic and metal under elevated temperatures and pressures so as to form a good hermetic seal.

12. The method as in claim 10 further comprising the step of alternating the vapor deposition, in small amounts, of two materials which comprise the brazing material, for example Ti and Ni.

13. The method as in claim 10 further comprising the step of utilizing a metal consisting mainly of Ni and Ti, each in a ratio of (100% - x%) of Ni by weight, to, x% of Ti by weight, where $1\% < x < 99\%$.

14. The method as in claim 10 further comprising the step of using a mixture of 50% by weight Ti and of 50% by weight Ni as the mixture/alloy for vapor deposition.

15. The method as in claim 1 further comprising the step of ion implanting brazing material onto the joining surface or the plurality of joining surfaces that is used instead of as well as together with the conical washer.

16. The method as in claim 15 further comprising the steps of:

a. applying elevated temperature; and

b. applying elevated pressure so as to facilitate the bonding of ceramic and metal under elevated temperatures and pressures so as to form a good hermetic seal.

17. The method as in claim 15 further comprising the step of alternating the ion implantation, in small amounts, of two materials which comprise the brazing material, for example Ti and Ni.

18. The method as in claim 15 further comprising the step of utilizing a brazing material consisting mainly of Ni and Ti, each in a ratio of (100% - x%) of Ni by weight, to x% of Ti by weight, where $1\% < x < 99\%$.

19. The method as in claim 15 further comprising the step of using a mixture of 50% by weight Ti and of 50% by weight Ni as the mixture/alloy for ion implantation.

20. The method as in claim 4 further comprising the steps of:

a. covering the areas of the parts which are not to receive the brazing substance with magnetically active material; and

b. turning on a local magnetic field that acts to hold down the parts being brazed.

21.The method as in claim 1, or claim 5, or claim 11, or claim 16 further comprising the steps of milling one side, and the other side, if required, of a joined structure comprising said conical and said mating object, wherein a controlled thinness of the joined structure is achieved.

22. The brazed surface which results from the application of the brazing material as in claim 4 or as in claim 10 or as in claim 15.

23. A highly effective hermetic seal comprising two surfaces joined together by a brazing compound wherein heat and pressure were applied to the brazing material and the two mated surface, further comprising a metal surface, a ceramic surface and a brazing substance consisting mainly of Ni and Ti, in a ratio of (100% - x%): x% respectively, by weight, where x may range from 1% to 99%.

24. The highly effective hermetic seal of claim 22, wherein one of the surfaces joined is conical and the cone angle, from the vertex, or, for a truncated cone, that cone angle which would exist, if the truncated cone were extended, is

θ, where $0.001° < \theta < 89.999°$ and further comprising the other surface to which the conical surface is joins, forms a mating surface which has a corresponding angle of $\psi = 180° - \theta$.

25. The highly effective hermetic seal of claim 23 wherein the brazing material is originally a conical washer before heat and pressure are applied.

26. The highly effective hermetic seal of claim 23 wherein the brazing material is originally sputtered on before heat and pressure are applied.

27. The highly effective hermetic seal of claim 23 wherein the brazing material is originally vapor deposited before heat and pressure are applied.

28. The highly effective hermetic seal of claim 23 wherein the brazing material is originally ion deposited.

29. The highly effective hermetic seal as in claim 24, or as in claim 25, or as in claim 26, wherein the brazing material comprised alternating thin layers of two materials which comprise the brazing material, for example Ti and Ni before the application of heat and temperature.

30. The highly effective hermetic seal as in claim 24 , as in claim 25, or as in claim 26, wherein said brazing material consists mainly of Ni and Ti, each in a ratio of (100% - x%) of Ni by weight, to x% of Ti by weight, where $1\% < x\% < 99\%$.

31. The highly effective hermetic seal as in claim 24, or as in claim 25, or as in claim 26, wherein said brazing material consists mainly of a mixture of 50% by weight Ti and of 50% by weight.

32. The manufacturing jig comprising a holding surface for the small parts to be brazed, one or more brazing apparatus, magnetically active covering material, e.g., iron, steel), and local field producing electromagnet(s), with switching mechanism(s) to turn it (them) on and off.

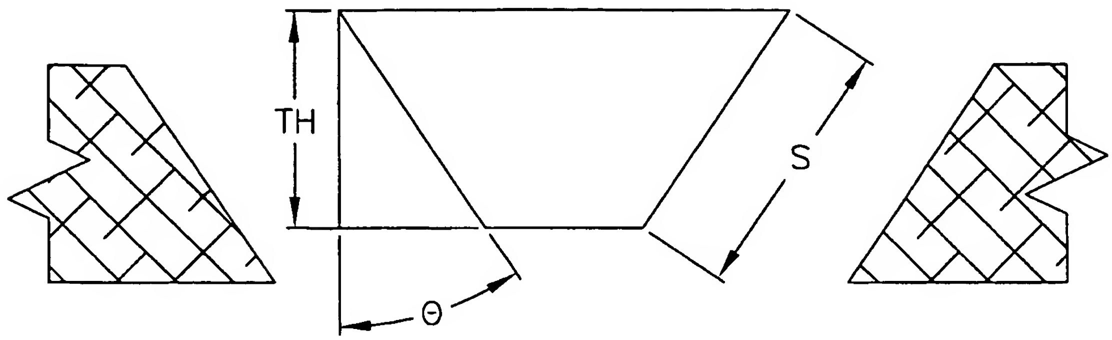

FIG. 1a

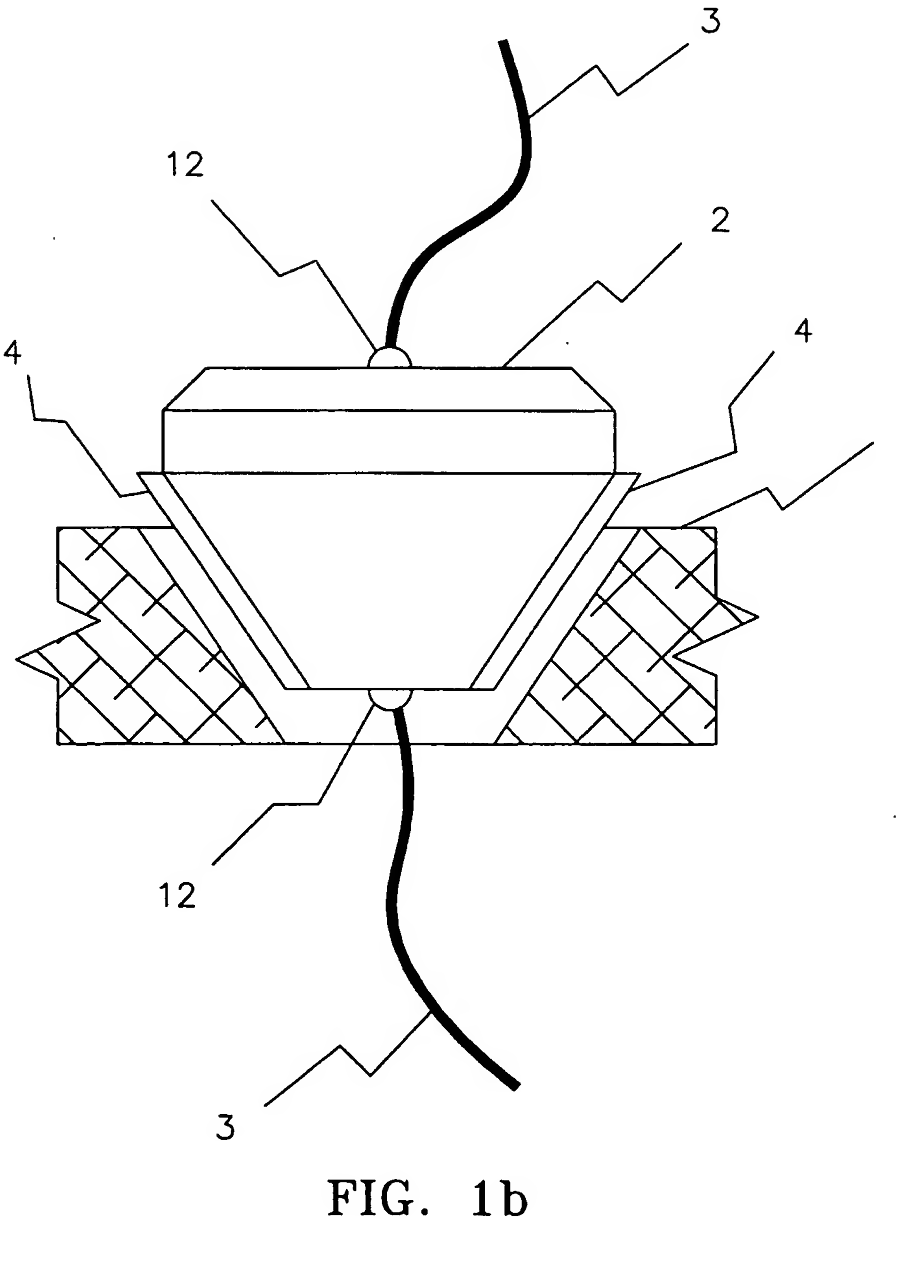

FIG. 1b

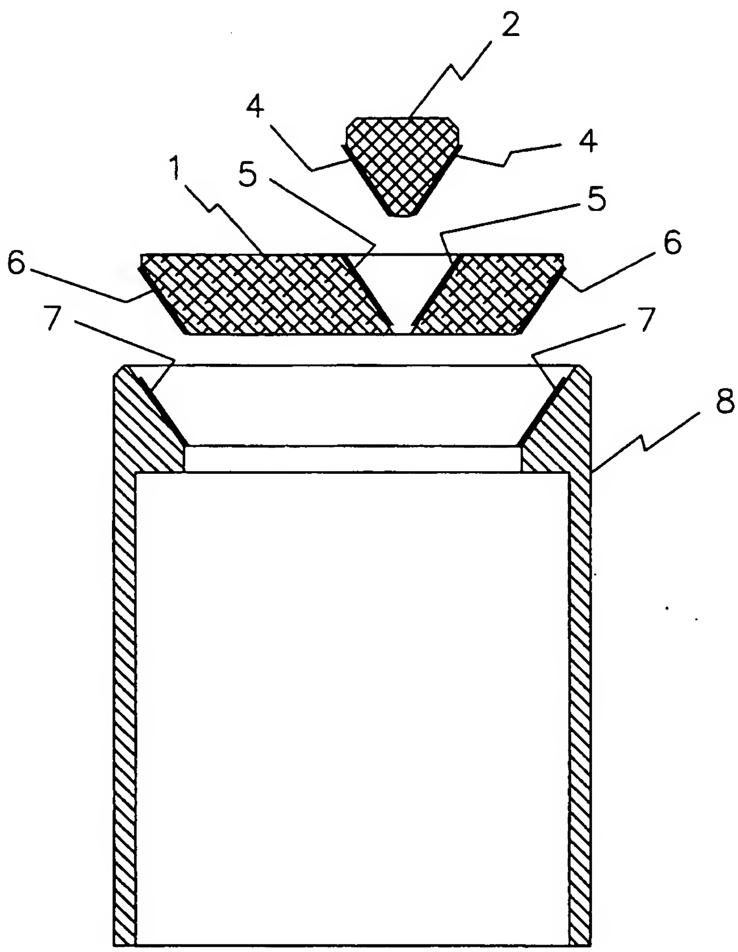

FIG 2

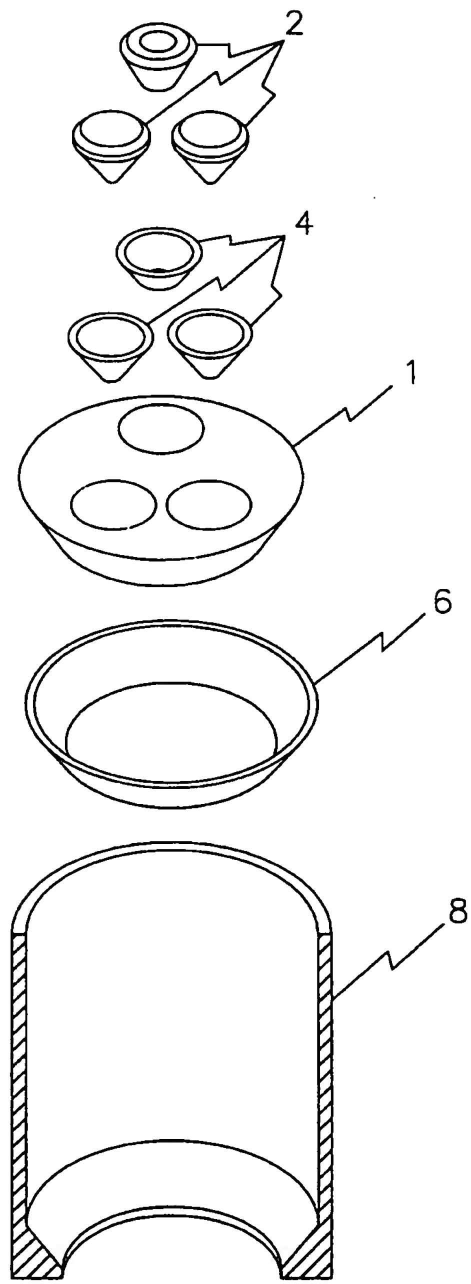

FIG 3

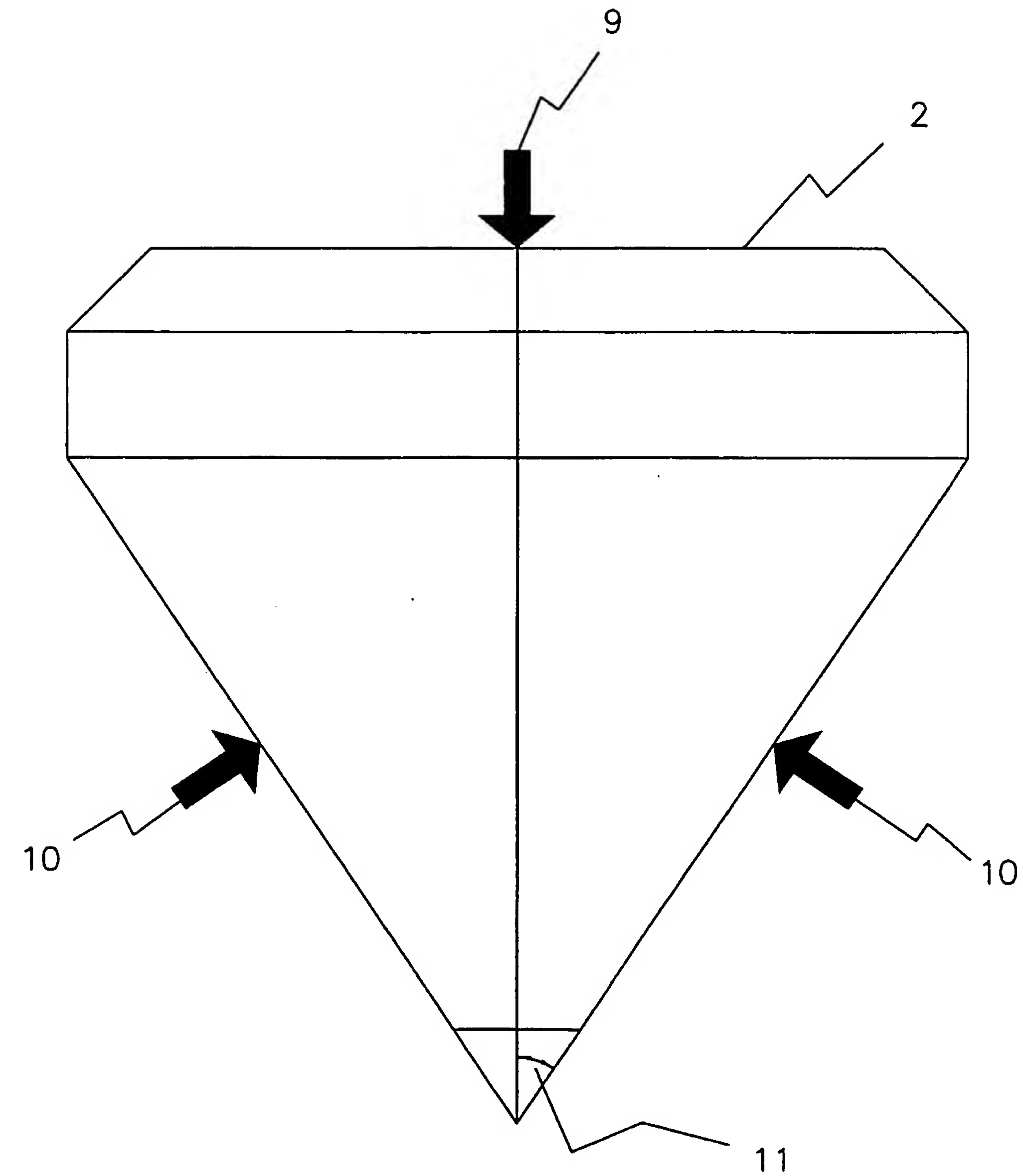

FIG 4

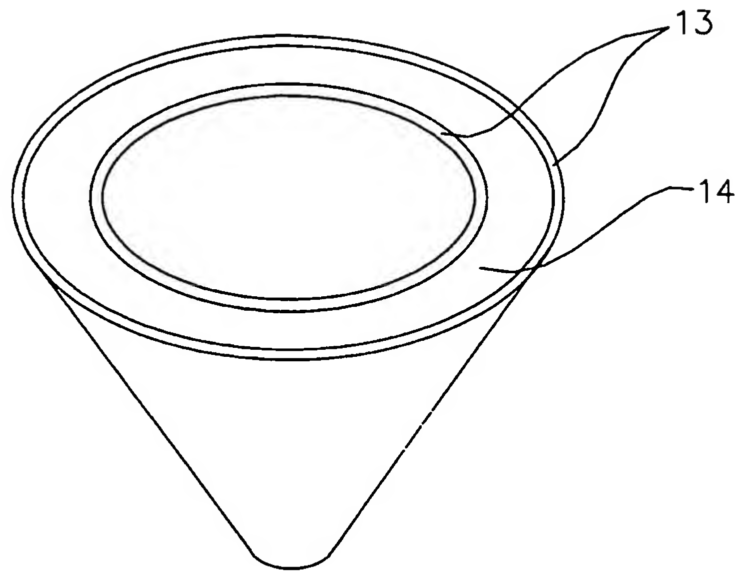

FIG. 5

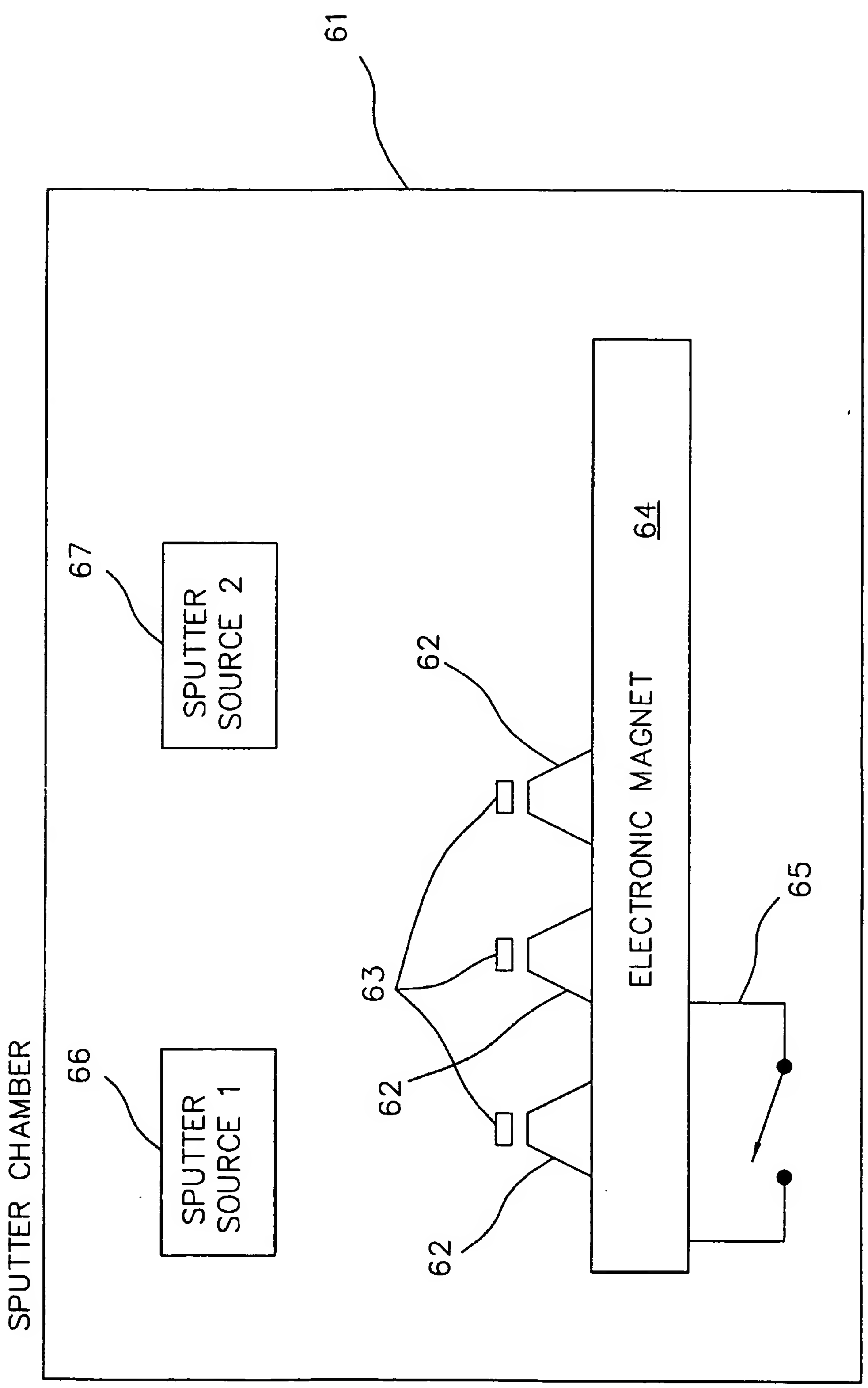
61
SPUTTER CHAMBER
66
SPUTTER SOURCE 1
67
SPUTTER SOURCE 2
62
63
62
62
ELECTRONIC MAGNET
64
65

Fig 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/27449

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B23K 1/14, 31/02, 37/04
US CL : 228/124.6; 44.3; 49.1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 228/124.6; 44.3; 49.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST
search terms: hermetic adj seal, (ni or nickel), (ti or titanium), fixture, jig

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,351,874 A (RAJNER et al) 04 October 1994, the abstract and columns 1-2.	1-22
A	US 5,779,081 A (KIMURA et al) 14 July 1998, the claims.	1-22
Y	US 3,662,455 A (ANDERSON) 16 May 1972, the abstract and columns 1-2.	23-31
Y	US 5,013,612 A (HUNT et al) 07 May 1991, columns 4-7.	23-31
Y	US 3,594,895 A (HILL et al) 27 July 1971, columns 1-2.	23-31
Y	US 4,725,509 A (RYAN) 16 February 1988, columns 3-6.	23-31

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
18 DECEMBER 2000

Date of mailing of the international search report
18 JAN 2001

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,195,239 A (BREUER et al) 23 March 1993, columns 1-5.	32
Y	US 4,368,908 A (GENTZEL, JR) 18 January 1983, columns 1-2.	32